MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 30-2016 (YEAR 2 OF 2)
2016 FINAL REPORT

Title: Screening of Pigweeds (*Amaranthus* spp.) for Resistance to PPO (Protoporphyrinogen Oxidase) Inhibiting Herbicides and Evaluation of Factors Affecting PPO Herbicide Efficacy

Name of PI and email address: Vijay Nandula; vijay.nandula@ars.usda.gov

SUMMARY

Resistance to PPO-inhibiting (WSSA Group 14) herbicides is evolving in Miss., but is not yet widespread in sampled populations of Miss. Palmer amaranth.

The objectives of the study reported here were to screen Miss. Delta pigweed populations for resistance to selected PPO-inhibiting (WSSA Group 14) herbicides, and to evaluate spray application factors that might affect efficacy of these herbicides.

Neither water quality, fomesafen formulation (Flexstar, Reflex, Top Gun), adjuvant type (crop oil concentrate or nonionic surfactant), rainfastness [0, 10, 30, 60, 120, and 240 min. after treatment (MAT)], nor nozzle type (9 different types) affected fomesafen efficacy on Palmer amaranth plants used in the study.

These results indicate that any reports of reduced efficacy of PPO-inhibiting herbicides on targeted weeds in Miss. fields must be taken seriously; i.e., the reported failures are in fact an indication that resistance to this class of herbicides has developed/is developing in targeted weeds at the location where weeds exhibiting resistance symptoms are found.

BACKGROUND

Widespread distribution of glyphosate-resistant (GR) weeds in soybean-growing areas across Mississippi has economically affected soybean planting and followup crop management operations. Several of the GR weeds, especially pigweeds (*Amaranthus* spp), are also resistant to acetolactate synthase (ALS)-inhibiting herbicides. Thus, protoporphyrinogen oxidase (PPO) inhibitors (WSSA Group 14 herbicides) are one of the few remaining postemergence (POST) weed control herbicide options, with another being glufosinate in LibertyLink® (glufosinate-tolerant) soybean, for soybean growers of Mississippi.

New multiple herbicide-resistant crop (including soybean) technologies with associated formulations have been deregulated (traits by USDA)/registered (herbicide formulations by EPA), but have run into registration problems recently. EPA revoked the approval of 2,4-D-resistant crop technology following an appeal by environmental groups and pending further evaluation of data from the manufacturer of the technology, Dow AgroSciences. In addition, resistance to PPO inhibiting herbicides has very recently been reported in Arkansas and Tennessee (http://deltafarmpress.com/weed-control/ppo-resistant-pigweeds-confirmed-arkansas-tennessee). Under these uncertain conditions, prolonging the sustainability of PPO herbicides for MS soybean producers is of paramount importance.

The objectives of the planned research are to screen pigweed populations collected from across the Miss. Delta region in the 2014 growing season for resistance to selected PPO inhibiting herbicides and to evaluate factors affecting efficacy of these herbicides. Greenhouse studies will be initiated to screen for PPO-inhibitor resistance under stringent conditions (younger growth stage of weed – 5 cm or less in height vs. the traditional 10 cm or less in height, 2X the labeled field rate, etc.) and factors affecting PPO inhibitor efficacy will be evaluated to determine if field failures of PPO inhibitors are due to resistance or misapplication/adverse application conditions. Results/data from the above research will tremendously aid Mississippi soybean growers in making prudent weed management decisions and increasing their profitability.

OBJECTIVES

1. To screen pigweed populations collected from across the MS Delta region for resistance to selected PPO-inhibiting (WSSA Group 14) herbicides.
2. To evaluate factors affecting efficacy of PPO inhibiting herbicides.

REPORT OF PROGRESS/ACTIVITY

Objective 1: Tests for resistance to PPO inhibitors in approximately 200 pigweed accessions comprising Palmer amaranth, tall waterhemp, spiny amaranth, and redroot pigweed collected across all counties of Miss. indicated variable survival following POST treatments of fomesafen and/or lactofen (both WSSA Group 14 herbicides). None of the pigweed accessions emerged through a PRE flumioxazin treatment.

Thereafter, Palmer amaranth tissue samples collected from reported PPO inhibitor failures in the field from multiple counties in the Mississippi Delta were sent to a lab at the University of Illinois for resistance identification via a molecular genetics test. All samples tested negative for the presence of a known deletion mutation in the resistant PPO gene. Additionally, 100 Palmer amaranth seed samples collected at random from fields in 10 counties in the Mississippi Delta in 2015 were screened with fomesafen at 0.42 kg ai/ha (0.375 lb ai/A). Among the 100 Palmer amaranth samples tested, 38 had plants that survived the herbicide application at 21 days after application (DAA). The percent survival among treated plants ranged from 6 to 67%.

Summary: Resistance to PPO inhibitors in pigweed populations of Mississippi is an evolving problem in its nascent stage and not widespread in the state compared to neighboring states such as Arkansas and Tennessee.

Objective 2: Fomesafen was applied at 0.42 kg ai ha^{-1} (the single highest dose recommended in Mississippi) in all experiments. All herbicide treatments were evaluated for efficacy based on % control ratings (0=no injury, 100=dead) recorded 3 weeks after treatment (WAT). In the Water Quality and Formulation study, % mortality was derived based on number of plants surviving or the herbicide treatment with lack of green tissue at 3 WAT considered as death.

Water Quality and Formulation. All water samples were collected in 2016 in clean (new or used) 3.8-L plastic containers and stored at 2 to 8 deg. C until further use. Water sources included city or well at the mixing facilities of participating members, which included commercial applicators of the Mississippi Agricultural Aviation Association, county agents, and industry representatives (Table 1, Fig. 2). Aircraft applicators made up a bulk of the chosen sources since they apply herbicides on the largest crop area based on unit water source. An aliquot of each water sample was analyzed for selected properties by a commercial agricultural analytical laboratory (Waypoint Analytical, Memphis, TN). A representative analytical report is shown in Fig. 2. Palmer amaranth plants that were 5- to 10-cm tall with 3 to 6 true leaves were treated with three fomesafen formulations [Flexstar® (formulation 1, Syngenta Crop Protection, Greensboro, NC), Reflex® (formulation 2, Syngenta Crop Protection), and Top Gun® (formulation 3, Loveland Products, Inc., Greeley, CO)] at 0.42 kg ai/ha using city or well water samples as the spray carrier. All treatments had crop oil concentrate (COC, Agridex®, Helena Chemical Co., Collierville, TN) at 1% v/v.

Analytical reports (Fig. 2) for each water sample included individual estimates of cations such as Na, Ca, Mg, K, and NH_4, anions such as Cl, SO4, S, HCO3, CO3, NO3, PO4, and P, minerals such as Cu, Zn, Mn, Fe, B, F, Al, and Mo, and other parameters such as pH, electrical conductivity, and hardness. Herbicide applicators will, no doubt, add buffering and conditioning agents to the water before large scale treatment of fields. However, we did not add any amendments to the water samples before testing for efficacy of fomesafen on Palmer amaranth. All results including analytical reports and efficacy results have been shared with cooperating aircraft applicators, county agents and growers.

There was no significant effect of water quality, formulation, or the water quality x formulation interaction on Palmer amaranth control and mortality (data not shown). All water samples and formulation combinations provided >95% control of Palmer amaranth 3 WAT (data not shown). Some combinations of water samples and formulations did not result in complete control of the treated plants, with one or two surviving 3 WAT (Table 2). Overall, water quality did not adversely affect the efficacy of any of the three fomesafen formulations evaluated.

Formulation and Adjuvant. Both formulations 1 and 2 were applied with a nonionic surfactant (NIS, Induce®, Helena Chemical Co.) at 0.25% v/v and a COC at 1% v/v to plants at 4 different growth stages—2.9 to 3.8 cm, 5.6 to 7 cm, 9.1 to 9.6 cm, and 11.6 to 13.5 cm.

Among main and interaction effects, only the formulation main effect significantly impacted control of Palmer amaranth (Table 3). Formulation 1 provided 99% control compared to 95% from formulation 2. Regardless of combinations of herbicide, adjuvant, and plant height, control of Palmer amaranth was 91% or more (Table 3).

Adjuvant Rate. Both formulations 1 and 2 were applied with an NIS at 0.25 and 0.5% v/v and a COC at 1 and 2% v/v to plants at 2 different growth stages, 11.5 to 15.5 and 24.8 to 26.8 cm.

Among main effects, formulation significantly affected control of Palmer amaranth (Table 4). Formulation 1 provided 94% control compared to 88% from formulation 2. The adjuvant x height interaction was significant due to a 10% reduction in control of larger plants (86%) compared to smaller plants (96%) in the presence of COC (Table 4).

Rainfastness. Both formulations 1 and 2 were applied with an NIS at 0.25% v/v and a COC at 1% v/v to 10-cm-tall plants. Treated plants were sprayed with simulated rainfall amounting to

0.5 cm (according to Reddy and Locke 1996) for a duration of 0, 10, 30, 60, 120, and 240 min after application (MAT). After each rainfall timing, plants were returned to the greenhouse.

Adjuvant type had a significant effect on Palmer amaranth control (Table 5). COC provided better control (93%) than NIS (88%). The three-way interaction between formulation adjuvant and rainfall timing after herbicide treatment was significant for Palmer amaranth control. Simulated rainfall applied 60 or more minutes after herbicide application did not adversely affect efficacy on Palmer amaranth when formulation 1 was applied in combination with NIS, with control ranging from 94 to 100%. Formulation 1 with COC provided 93% or better control at all rainfall application times, except 30 min after herbicide treatment, which resulted in 79% control. Formulation 2 provided better control with COC (79 to 100%) than with NIS (71 to 90%), in general, across the rainfall treatments applied at various times following herbicide application.

Nozzle. In this experiment, nine different nozzles, 8002, Airmix 110-02 (agrotop, Obertraubling, Germany), TT360, AITT36011002, AI11002VS, TTI02, DG11002VS, AIXR11002, 11002, were evaluated. All other nozzles were acquired from Spraying Systems Co., Wheaton, IL, USA. Formulation 2 was applied with a COC at 1% v/v to plants at 3 growth stages, 4.25 to 6, 6.13 to 8, and 10.4 to 13.8 cm.

Neither of the main effects, nozzle type nor height of Palmer amaranth, nor their interaction significantly affected Palmer amaranth control when treated with formulation 2 in combination with COC (Table 6). All nozzle and weed height combinations resulted in 89% or better control of Palmer amaranth (Table 6).

Summary: Water quality, formulation, adjuvant, rainfastness, and nozzle type did not affect efficacy of fomesafen on Palmer amaranth, and any reports of PPO inhibitor failures in the field must be taken seriously after considering the role of these factors on each individual reported case.

Table 1. Details of water sampling locations and summary of water quality analysis.[a]

Sample#	County	Source	pH	Hardness	Fe	CO_3	HCO_3	Na	Cl
				mg L^{-1}					
1	Bolivar	City	8.3	2.09	0.06	22	333	171	45
2	Bolivar	City	8.3	8.08	0.36	24	478	418	242
3	Bolivar	Well	8.1	449	0.8	39	384	18	37
4	Bolivar	City	8.4	18.2	0.35	36	323	166	39
5	Bolivar		8.7	1.33	0.05	39	101	100	30
6	Bolivar	City	8.5	4.46	0.05	29	483	231	35
7	Bolivar	City	8.6	2.07	0.06	34	434	189	20
8	Bolivar	City	8.3	22.4	0.05	39	338	163	37
9	Coahoma	Well	8.0	277	0.53	39	197	12	42
10	DeSoto	Well	7.7	266	13.7	0	278	14	14
11	DeSoto	City	8.0	12.2	0.16	10	145	65	11
12	Humphreys		8.2	5.34	0.09	24	163	78	18
13	Humphreys		8.3	1.95	0.05	22	163	90	12
14	Issaquena		8.6	3.06	0.05	49	483	282	81
15	Issaquena		8.4	3.04	0.05	29	471	281	75
16	Leflore		8.0	240	1.48	32	249	11	17
17	Leflore		8.4	3.89	0.05	49	259	136	7
18	Leflore		8.4	12.6	0.06	44	293	138	12
19	Leflore		8.5	3.98	0.05	39	269	126	12
20	Leflore		8.5	2.73	0.05	19	259	127	7
21	Madison		8.2	6.6	0.05	39	212	172	41
22	Sharkey	Well	7.9	419	2.22	27	419	15	11
23	Sharkey		9.0	1.78	0.05	87	392	223	30
24	Sharkey		8.7	2.43	0.05	36	394	201	33
25	Sharkey		8.5	2.42	0.05	44	382	199	36
26	Tallahatchie	City	8.4	8.81	0.05	10	328	408	289
27	Tallahatchie	City	8.3	3.81	0.12	24	274	147	27
28	Tallahatchie		7.9	18.4	0.05	19	163	72	21
29	Tallahatchie		8.5	4.37	0.14	51	234	121	28
30	Tallahatchie		8.0	7.23	0.2	27	269	148	41
31	Washington		8.1	76.5	0.05	32	338	116	22
32	Washington	Well	8.7	2.61	0.05	61	407	231	20
33	Washington		8.7	2.56	0.07	63	490	314	100
34	Washington		8.0	384	1.21	36	421	47	30
35	Washington		8.5	6.39	0.05	58	333	177	30
36	Washington		8.0	76	0.68	34	446	226	65
37	Washington	City	8.4	3.09	0.05	32	224	151	38

38	Washington	Well	9.1	2.36	0.05	95	352	241	81
39		Distilled Water	6.1	1.05	0.05	0	10	0	5

[a] The levels for each of the water quality parameters indicating severe, slight to moderate, and no problems/issues, respectively, were established as follows: pH: >7.9, <5.8 and 7.1-7.9, 5.8-7; hardness: >180, 60-180, <60; Fe: >1.5, 0.3-1.5, <0.3; CO_3: >510, 120-510, <120; HCO_3: >519, 122-519, <122; Na: >138, 69-138, <69; Cl: >179, 107-179, <10

Table 2. Effect of water quality and fomesafen formulation (1 = Flexstar, 2 = Reflex, 3 = Top Gun) on Palmer amaranth mortality 3 wk after treatment.

Fomesafen	Sample#	Mortality
		%
Formulation 1	1	90
	2	95
	4	90
Formulation 2	1	95
	2	95
	3	90
	4	90
	5	95
	7	95
	31	95
	37	95
	39	95
Formulation 3	1	95
	4	95
	6	95
	7	95
	36	95
	38	95
	39	95

Table 3. Effect of fomesafen formulation (1 = Flexstar, 2 = Reflex) and adjuvant (NIS = nonionic surfactant; COC = crop oil concentrate) on Palmer amaranth control 3 wk after treatment.

Main/Interaction factor			P value	Control
				%
Formulation 1				99
Formulation 2				95
LSD (0.05)				3
Formulation			0.0116	
Adjuvant			0.9391	
Height			0.1927	
Formulation x adjuvant			0.7599	
Formulation x height			0.5037	
Adjuvant x height			0.6252	
Formulation x adjuvant x height			0.9470	
Main factor				
Formulation 1	NIS	Height 1		100
		Height 2		100
		Height 3		100
		Height 4		98
	COC	Height 1		100
		Height 2		96
		Height 3		99
		Height 4		100
Formulation 2	NIS	Height 1		100
		Height 2		94
		Height 3		91
		Height 4		93
	COC	Height 1		100
		Height 2		91
		Height 3		94
		Height 4		95

Table 4. Effect of fomesafen formulation (1 = Flexstar, 2 = Reflex), adjuvant (NIS = nonionic surfactant, COC = crop oil concentrate), and adjuvant rate on Palmer amaranth control 3 wk after treatment.

Main/Interaction factor				P value	Control
					%
Formulation 1					94
Formulation 2					88
LSD (0.05)					5
	NIS		Height 1		88
			Height2		93
	COC		Height1		97
			Height2		86
LSD (0.05)					7
Formulation				0.0111	
Adjuvant				0.6864	
Adjuvant rate				0.1658	
Height				0.2182	
Formulation x adjuvant				0.6180	
Formulation x adjuvant rate				0.4449	
Formulation x height				0.8866	
Adjuvant x height				0.0049	
Formulation x adjuvant x adjuvant rate				0.1822	
Formulation x adjuvant x height				0.0548	
Formulation x adjuvant x adjuvant rate x height				0.1281	
Main factor					
Formulation 1	NIS	0.25	Height 1		94
			Height 2		97
		0.5	Height 1		95
			Height 2		92
	COC	1	Height 1		96
			Height 2		96
		2	Height 1		98
			Height 2		88
Formulation 2	NIS	0.25	Height 1		87
			Height 2		84
		0.5	Height 1		77
			Height 2		98
	COC	1	Height 1		100
			Height 2		89
		2	Height 1		94
			Height 2		73

Table 5. Effect of rainfastness (MAT = minutes after treatment) on efficacy of fomesafen (1 = Flexstar, 2 = Reflex) on Palmer amaranth 3 wk after treatment.

Main/Interaction factor			P value	Control
				%
NIS				93
COC				88
LSD (0.05)				5
Formulation 1	NIS	MAT 0		86
		MAT 10		85
		MAT 30		85
		MAT 60		100
		MAT 120		94
		MAT 240		100
	COC	MAT 0		100
		MAT 10		95
		MAT 30		79
		MAT 60		100
		MAT 120		98
		MAT 240		93
Formulation 2	NIS	MAT 0		90
		MAT 10		89
		MAT 30		89
		MAT 60		83
		MAT 120		88
		MAT 240		71
	COC	MAT 0		79
		MAT 10		90
		MAT 30		87
		MAT 60		100
		MAT 120		96
		MAT 240		100
LSD (0.05)				3
Formulation			0.0556	
Adjuvant			0.0407	
MAT			0.1159	
Formulation x adjuvant			0.3040	
Formulation x MAT			0.2892	
Adjuvant x MAT			0.4768	
Formulation x adjuvant x MAT			0.0063	

Table 6. Effect of nozzle type on efficacy of fomesafen on Palmer amaranth 3 wk after treatment.

Main/Interaction factor		P value	Control
			%
Nozzle type		0.3755	
Height		0.2051	
Nozzle type x Height		0.9204	
Nozzle 1	Height 1		100
	Height 2		95
	Height 3		100
Nozzle 2	Height 1		100
	Height 2		100
	Height 3		100
Nozzle 3	Height 1		100
	Height 2		100
	Height 3		95
Nozzle 4	Height 1		100
	Height 2		98
	Height 3		90
Nozzle 5	Height 1		94
	Height 2		100
	Height 3		89
Nozzle 6	Height 1		94
	Height 2		100
	Height 3		89
Nozzle 7	Height 1		100
	Height 2		100
	Height 3		100
Nozzle 8	Height 1		100
	Height 2		100
	Height 3		100
Nozzle 9	Height 1		100
	Height 2		100
	Height 3		100

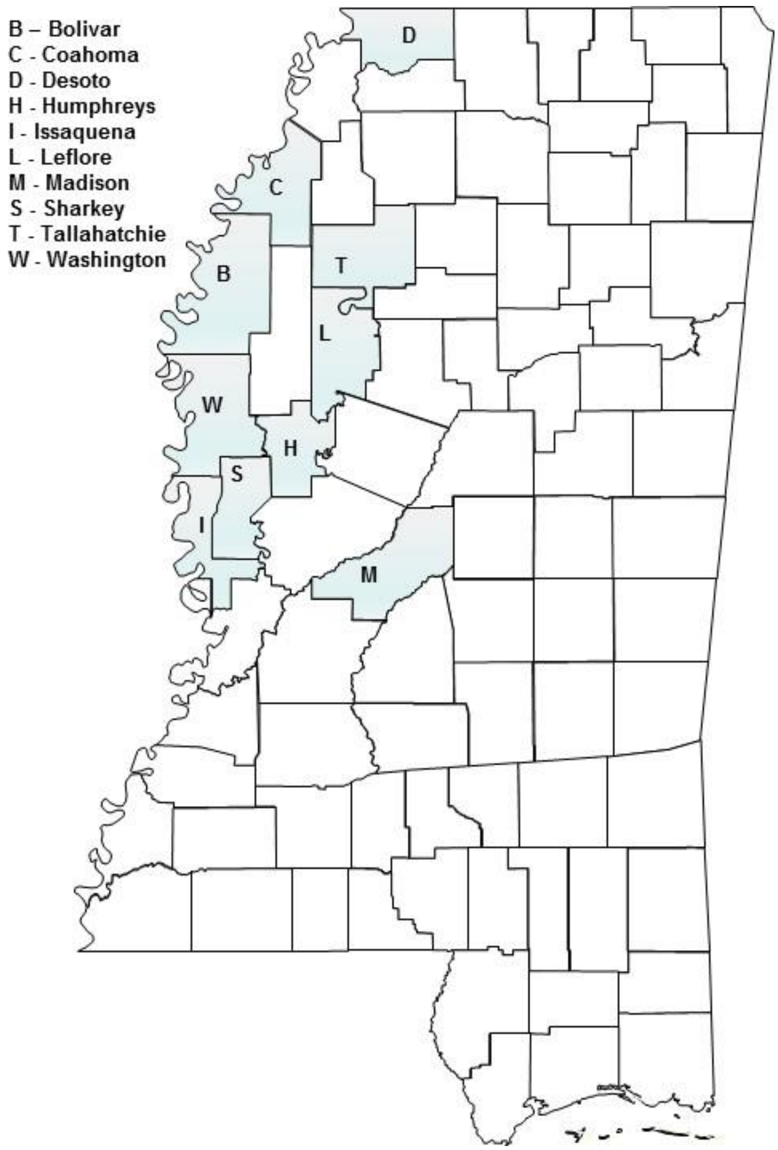
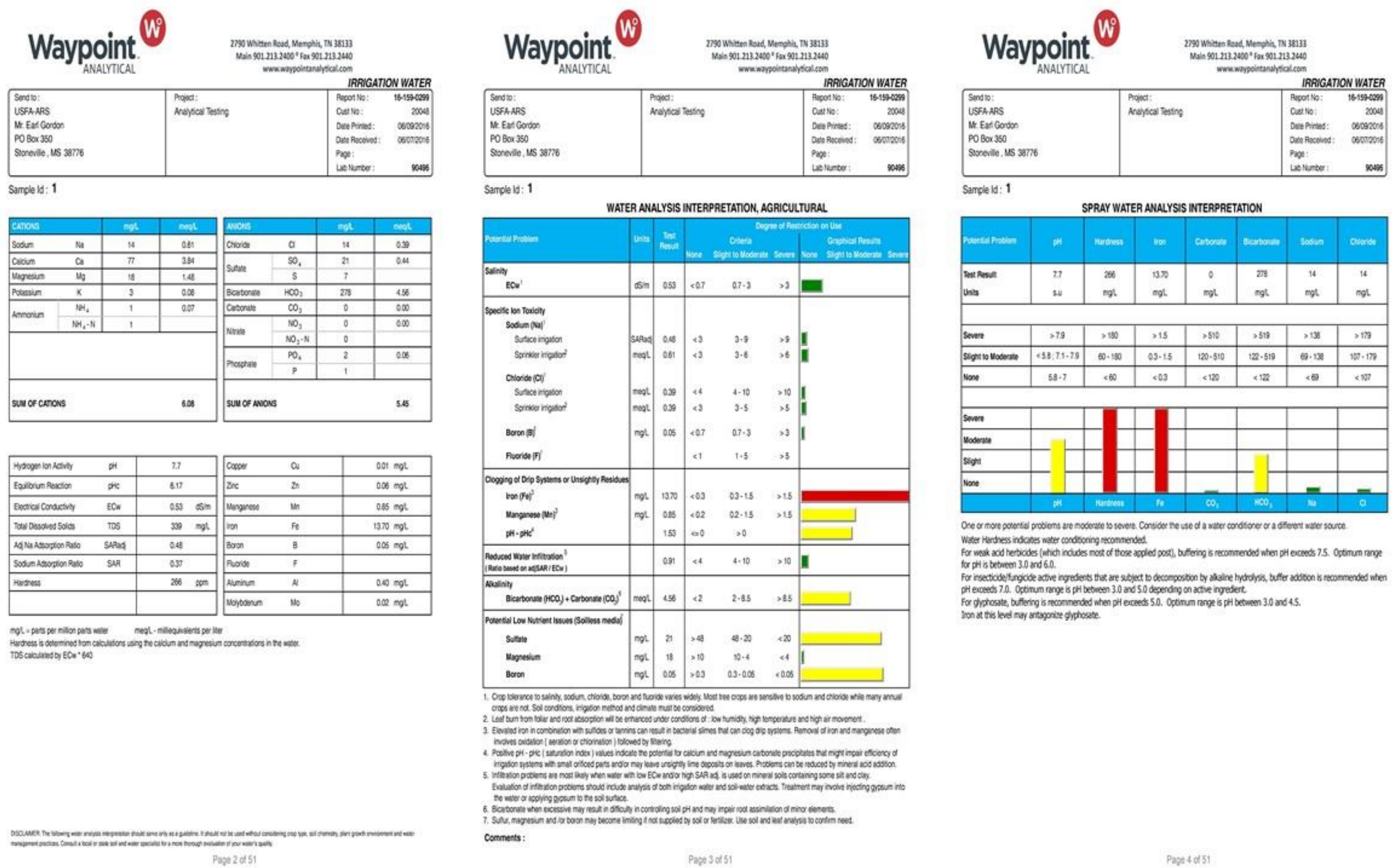


Figure 1. Map of counties in Mississippi where water samples were collected.



Waypoint ANALYTICAL

2790 Whitten Road, Memphis, TN 38133
Main 901.213.2400 * Fax 901.213.2440
www.waypointanalytical.com

IRRIGATION WATER

Send to :	Project :	
USFA-ARS	Analytical Testing	Report No : 16-159-0299
Mr. Earl Gordon		Cust No : 20048
PO Box 350		Date Printed : 06/09/2016
Stoneville , MS 38776		Date Received : 06/07/2016
		Page :
		Lab Number : 90496

Sample Id : 1

CATIONS		mg/L	meq/L
Sodium	Na	14	0.61
Calcium	Ca	77	3.84
Magnesium	Mg	18	1.48
Potassium	K	3	0.08
Ammonium	NH_4	1	0.07
	NH_4-N	1	
SUM OF CATIONS			6.08

ANIONS		mg/L	meq/L
Chloride	Cl	14	0.39
Sulfate	SO_4	21	0.44
	S	7	
Bicarbonate	HCO_3	278	4.56
Carbonate	CO_3	0	0.00
Nitrate	NO_3	0	0.00
	NO_3-N	0	
Phosphate	PO_4	2	0.06
	P	1	
SUM OF ANIONS			5.45

Hydrogen Ion Activity	pH	7.7	
Equilibrium Reaction	pHc	6.17	
Electrical Conductivity	ECw	0.53	dS/m
Total Dissolved Solids	TDS	339	mg/L
Adj Na Adsorption Ratio	SARadj	0.48	
Sodium Adsorption Ratio	SAR	0.37	
Hardness		266	ppm

Copper	Cu	0.01	mg/L
Zinc	Zn	0.06	mg/L
Manganese	Mn	0.85	mg/L
Iron	Fe	13.70	mg/L
Boron	B	0.05	mg/L
Fluoride	F		
Aluminum	Al	0.40	mg/L
Molybdenum	Mo	0.02	mg/L

mg/L = parts per million parts water   meq/L - milliequivalents per liter
Hardness is determined from calculations using the calcium and magnesium concentrations in the water.
TDS calculated by ECw * 640

DISCLAIMER: The following water analysis interpretation should serve only as a guideline. It should not be used without considering crop type, soil chemistry, plant growth environment and water management practices. Consult a local or state soil and water specialist for a more thorough evaluation of your water's quality.

Page 2 of 51

Waypoint ANALYTICAL

2790 Whitten Road, Memphis, TN 38133
Main 901.213.2400 * Fax 901.213.2440
www.waypointanalytical.com

IRRIGATION WATER

Send to : USFA-ARS, Mr. Earl Gordon, PO Box 350, Stoneville , MS 38776 — Project : Analytical Testing — Report No : 16-159-0299, Cust No : 20048, Date Printed : 06/09/2016, Date Received : 06/07/2016, Page :, Lab Number : 90496

Sample Id : 1

WATER ANALYSIS INTERPRETATION, AGRICULTURAL

Potential Problem	Units	Test Result	Degree of Restriction on Use: Criteria – None	Slight to Moderate	Severe
Salinity					
ECw[1]	dS/m	0.53	< 0.7	0.7 - 3	> 3
Specific Ion Toxicity					
Sodium (Na)[1]					
Surface irrigation	SARadj	0.48	< 3	3 - 9	> 9
Sprinkler irrigation[2]	meq/L	0.61	< 3	3 - 6	> 6
Chloride (Cl)[1]					
Surface irrigation	meq/L	0.39	< 4	4 - 10	> 10
Sprinkler irrigation[2]	meq/L	0.39	< 3	3 - 5	> 5
Boron (B)[1]	mg/L	0.05	< 0.7	0.7 - 3	> 3
Fluoride (F)[1]			< 1	1 - 5	> 5
Clogging of Drip Systems or Unsightly Residues					
Iron (Fe)[3]	mg/L	13.70	< 0.3	0.3 - 1.5	> 1.5
Manganese (Mn)[3]	mg/L	0.85	< 0.2	0.2 - 1.5	> 1.5
pH - pHc[4]		1.53	<= 0	> 0	
Reduced Water Infiltration[5] (Ratio based on adjSAR / ECw)		0.91	< 4	4 - 10	> 10
Alkalinity					
Bicarbonate (HCO_3) + Carbonate (CO_3)[6]	meq/L	4.56	< 2	2 - 8.5	> 8.5
Potential Low Nutrient Issues (Soilless media)[7]					
Sulfate	mg/L	21	> 48	48 - 20	< 20
Magnesium	mg/L	18	> 10	10 - 4	< 4
Boron	mg/L	0.05	> 0.3	0.3 - 0.05	< 0.05

Graphical Results: None / Slight to Moderate / Severe

1. Crop tolerance to salinity, sodium, chloride, boron and fluoride varies widely. Most tree crops are sensitive to sodium and chloride while many annual crops are not. Soil conditions, irrigation method and climate must be considered.
2. Leaf burn from foliar and root absorption will be enhanced under conditions of : low humidity, high temperature and high air movement .
3. Elevated iron in combination with sulfides or tannins can result in bacterial slimes that can clog drip systems. Removal of iron and manganese often involves oxidation (aeration or chlorination) followed by filtering.
4. Positive pH - pHc (saturation index) values indicate the potential for calcium and magnesium carbonate precipitates that might impair efficiency of irrigation systems with small orificed parts and/or may leave unsightly lime deposits on leaves. Problems can be reduced by mineral acid addition.
5. Infiltration problems are most likely when water with low ECw and/or high SAR adj. is used on mineral soils containing some silt and clay. Evaluation of infiltration problems should include analysis of both irrigation water and soil-water extracts. Treatment may involve injecting gypsum into the water or applying gypsum to the soil surface.
6. Bicarbonate when excessive may result in difficulty in controlling soil pH and may impair root assimilation of minor elements.
7. Sulfur, magnesium and /or boron may become limiting if not supplied by soil or fertilizer. Use soil and leaf analysis to confirm need.

Comments :

Page 3 of 51

Waypoint ANALYTICAL

2790 Whitten Road, Memphis, TN 38133
Main 901.213.2400 * Fax 901.213.2440
www.waypointanalytical.com

IRRIGATION WATER

Send to : USFA-ARS, Mr. Earl Gordon, PO Box 350, Stoneville , MS 38776 — Project : Analytical Testing — Report No : 16-159-0299, Cust No : 20048, Date Printed : 06/09/2016, Date Received : 06/07/2016, Page :, Lab Number : 90496

Sample Id : 1

SPRAY WATER ANALYSIS INTERPRETATION

Potential Problem	pH	Hardness	Iron	Carbonate	Bicarbonate	Sodium	Chloride
Test Result	7.7	266	13.70	0	278	14	14
Units	s.u	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Severe	> 7.9	> 180	> 1.5	> 510	> 519	> 138	> 179
Slight to Moderate	< 5.8 ; 7.1 - 7.9	60 - 180	0.3 - 1.5	120 - 510	122 - 519	69 - 138	107 - 179
None	5.8 - 7	< 60	< 0.3	< 120	< 122	< 69	< 107

One or more potential problems are moderate to severe. Consider the use of a water conditioner or a different water source.
Water Hardness indicates water conditioning recommended.
For weak acid herbicides (which includes most of those applied post), buffering is recommended when pH exceeds 7.5. Optimum range for pH is between 3.0 and 6.0.
For insecticide/fungicide active ingredients that are subject to decomposition by alkaline hydrolysis, buffer addition is recommended when pH exceeds 7.0. Optimum range is pH between 3.0 and 5.0 depending on active ingredient.
For glyphosate, buffering is recommended when pH exceeds 5.0. Optimum range is pH between 3.0 and 4.5.
Iron at this level may antagonize glyphosate.

Page 4 of 51

Figure 2. A representative water analysis report.